DIRECT TESTIMONY OF

SCOTT ROBINSON

ON BEHALF OF

DOMINION ENERGY SOUTH CAROLINA, INC.

DOCKET NO. 2019-182-E

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND OCCUPATION.

A. My name is Scott Robinson. I am an Associate Director in the Advanced Solutions group at Guidehouse, formerly Navigant Consulting, Inc. My business address is 1375 Walnut Street, Boulder, CO. Today, I will be filing testimony on behalf of Dominion Energy South Carolina, Inc. ("DESC").

Q. BRIEFLY STATE YOUR EDUCATION, BACKGROUND, AND EXPERIENCE.

A. I have Masters degrees from the University of Texas at Austin's Jackson School of Geoscience in the Energy and Earth Resources program, and the University of Texas at Austin's Lyndon B. Johnson School of Public Affairs. I have published multiple peer reviewed journal articles on modeling the adoption of distributed solar photovoltaics (PV).[1] For the last six years, I have worked in

[1] Robinson, S. A., & Rai, V. (2015). Determinants of spatio-temporal patterns of energy technology adoption: An agent-based modeling approach. *Applied Energy*, *151*, 273-284; Rai, V., & Robinson, S. A. (2013). Effective information channels for reducing costs of environmentally-friendly technologies: evidence from residential PV markets. *Environmental Research Letters*, *8*(1), 014044; Rai, V., & Robinson, S. A. (2015). Agent-based modeling of energy technology adoption: Empirical integration of social, behavioral, economic, and environmental factors. *Environmental Modelling & Software*, *70*, 163-177.

distributed energy resources, transportation electrification, and energy efficiency at Guidehouse. My clients include state and local governments, utilities, and utility regulatory agencies on topics related to the modeling and impact of technology adoption, including solar PV.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA (THE "COMMISSION")?

A. No, I have never testified before the Commission. However, I have been published extensively in the area of distributed behind the meter solar PV adoption, and with Guidehouse, I have conducted distributed solar PV adoption forecasts in seven states, including a similar study for Dominion Energy filed with the Virginia State Corporation Commission.

Q. HAVE YOU INCLUDED ANY EXHIBITS WITH YOUR TESTIMONY?

A. Yes. I have attached Exhibit No. __ (SR-1), which is entitled "Dominion Energy South Carolina Solar PV Forecast," dated October 07, 2020 (the "Solar Forecast"). I directed this study, which forms the basis for my opinions expressed in this testimony, and fulfills the Commission's requirement that DESC provide a forecast of "solar distributed generation in [DESC's territory] for the next 10 years."[2]

[2] This requirement arises from the Commission Directive issued in this Docket on August 26, 2020, which required that DESC provide additional items under the cost-benefit analysis performed in this docket pursuant to Act 62.

Q. WHAT ARE YOUR RESPONSIBILITIES AT GUIDEHOUSE?

A. I focus on quantitative forecasting and simulation of distributed energy, alternative fuel vehicle, and energy efficiency technologies. I lead teams of modelers and am responsible for several of our flagship distributed energy resource adoption models including DSMSim™, VAST™, GRIP™, and ReSim™ which was used to develop the distributed solar forecast for DESC. My responsibilities include managing model feature integration, quality and version control, and model enhancement planning. I frequently fill the role of senior modeler, technical quality manager, subject matter expert, lead modeler, or quality control lead on projects.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose is to sponsor testimony regarding (i) the forecast of distributed or behind-the-meter rooftop solar PV adoption in DESC's service territory as evidenced by the Solar Forecast, and (ii) the methodology and assumptions made by Guidehouse in the development of the Solar Forecast.

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. I am presenting analysis that suggests distributed rooftop solar PV installed capacity is expected to continue to grow in DESC territory through 2030 in a range of scenarios. Overall, the total installed capacity attributed to distributed solar photovoltaics is expected to increase by between 66% and 143% during the 2020-

2030 forecast period. The majority of capacity additions after the federal Investment Tax Credit ("ITC") sunset[3] are expected to occur in the Residential Single Family, Small Commercial, and Other Commercial sectors. The primary drivers of continued growth are favorable rate structures, state tax policy incentives, net-energy metering ("NEM"), and growth in the building stock within DESC territory.

Q. BRIEFLY DESCRIBE THE METHODOLOGY AND ASSUMPTIONS USED IN THE SOLAR FORECAST.

A. The Solar Forecast used an enhanced Bass diffusion model to estimate the market potential for solar PV in DESC's territory. We developed the forecast in Guidehouse's ReSim™ model, which uses a systems dynamics approach to characterize Technical, Eligible, Maximum Market, and Market potential. Technical potential is defined as the instantaneous amount of rooftop solar PV that could be installed, limited only by technical considerations such as shading, system sizing, and characteristics of the roof. Eligible potential accounts for technical considerations, and then also screens out renter populations and residential households with inadequate credit scores to secure a solar PV loan. Maximum Market, also referred to as Long Run Market potential in the Solar Forecast, accounts for customer preference, willingness to pay, and the economics of solar PV ownership in addition to technical and eligibility constraints. Finally, Market

[3] According to the "sunset" phase out period as currently scheduled, the ITC will ramp down to 22% in 2021, and 10% for commercial systems in 2022. In 2022 residential systems will receive no federal tax credit. The first step of this sunset occurred in 2020 when the credit ramped down from 30% to 26% for all customers.

potential accounts for the diffusion of information and customer awareness of technology. The Market potential is the basis for the forecast of installed rooftop solar PV capacity. Key assumptions used in the model were:

- Customer segmentation. Guidehouse segmented customers into six sectors: Single Family Residential, Small Commercial, Medium Commercial, Large Commercial, Other Commercial, and Industrial. These sectors were selected to align with DESC's load forecast. Multifamily and mobile home residential customers were excluded from the analysis.
- System size. Solar PV system sizes were calculated based on average energy usage per customer within each sector. Systems for Residential, Small Commercial, and Other Commercial customers were sized to meet 75% of annual customer energy consumption. Systems for Medium Commercial customers were sized to meet 50% of annual customer energy consumption. Systems for Large Commercial and Industrial customers were sized to meet 10% of annual customer energy consumption.
- Solar PV generation. System generation profiles were calculated using the National Renewable Energy Laboratory's System Advisor Model, using default configurations, weighted average azimuth, and typical meteorological year weather data from Columbia, SC. Systems were assumed to have a financial life of 20 years, with 0.5% annual degradation.[4]

[4] Degradation refers to decreasing energy output of the system over time due to oxidation, optical losses, and other factors.

- Electric Rates. For each sector, Guidehouse characterized rate components directly from DESC's 2020 rate schedules in terms of a base energy and demand, peak period energy and demand, tiers and tier thresholds, hourly time-of-use ("TOU") period definitions, and fixed charges. Sector-level weighted averages were developed for each of these components using the percentage of sector energy consumption associated with each electric rate. The study also assumes DESC's future rates increase with inflation (assumed to be 1.9%) based on the Bureau of Labor Statistics 10-year average annual inflation estimate.[5]
- Incentives. There are three major incentives in South Carolina that impact the distributed solar PV forecast.
    - **South Carolina Tax Incentives**. Taxpayers can claim a credit of 25% of the costs (up to $35,000) associated with purchasing and installing a solar PV system. The maximum credit a SC taxpayer may take in any one tax year is $3,500 for each facility or 50% of the taxpayer's tax liability for that year, whichever is less. Unused credit, or credit that exceeds the annual cap, may be carried forward for 10 years.
    - **Federal Investment Tax Credit**. The ITC allows the taxpayer to deduct a percentage of the cost of the solar PV system from their federal taxes. The original amount of the ITC was 30% of the installed system price. The ITC declined to 26% in 2020. As currently written, and assuming no further policy action, the ITC will adjust to 22% in 2021. For 2022 and

[5] Bureau of Labor Statistics CPI Calculator, https://www.bls.gov/data/inflation_calculator.htm. Accessed 9/6/2020

beyond, commercial customers will be able to deduct 10% while residential customers will have no credit. The analysis uses this current ITC sunset trajectory in the "Mid-Cost" and "High-Cost" scenarios. In the "Low-Cost" scenario, the Guidehouse assumes the ITC is extended in 2021 at 30% for all sectors.

- **NEM**. DESC's NEM tariff allows customers who own or lease distributed generation systems to sell excess electricity that is generated at times when their load is lower than the energy produced by their system to the utility and receive a credit to their electric bill. Currently, DESC customers who own renewable systems and qualify for NEM receive electricity credits at the full retail rate up to the full amount of their energy usage. Any unused excess energy credits are carried over to the next month at the full retail rate until the credits are fully utilized or until year-end. Any remaining credit at the year-end is compensated at the wholesale rate.

- Financial assumptions. The discounted cash flow model built into ReSim™ used in the Solar Forecast can capture the customer economics of lease, PPA, and loan purchase models. This analysis assumed a loan structure of 100% debt (no money down from the customer) to forecast the customer purchase economics. The loan term was assumed to be equal to the system financial life of 20 years, with a 5% interest rate. Annual electricity savings were calculated assuming DESC retail rates increase with the pace of inflation, estimated to be 1.9% per year. The customer discount rate used for incentive payments was 10% for commercial and industrial

customers, and 20% for residential customers. This is a compromise value between theoretical "rational" values and those observed in discrete choice experiments.[6]

- Solar PV Price. Solar PV prices were modeled based on individual system components, direct labor, permitting, overhead, margin, sales and marketing, and balance of system costs. Residential system prices are expected to fall from between $2.4 – $2.9/Watt DC in 2020 to $2.01 - $2.5/Watt DC in 2030. Commercial and Industrial system prices are expected to fall from between $1.52 – $1.86/Watt DC in 2020 to $1.26 - $1.56/Watt DC in 2030.

Q. DESCRIBE THE SCENARIOS DEVELOPED IN THE SOLAR FORECAST.

A. To account for uncertainty, three scenarios were explored in the analysis, labeled "High-Cost," "Mid-Cost," and "Low-Cost." These scenarios were developed to address a range of potential future policies and solar PV price trajectories. The "Mid-Cost" scenario reflects business as usual conditions, and thus uses the middle range of the solar PV price forecast and assumes the currently in-place ITC sunset trajectory as described above. The "High-Cost" scenario also assumes the ITC sunset in 2022 but uses the higher range of customer system prices. The "Low-Cost" scenario assumes an extension of the ITC in 2022, and uses the lower range of customer solar PV system prices. Guidehouse included the extension

[6] The customer discount rate implied from decision making is higher than might be assumed by rational actor theory, which might peg the discount rate on long-run returns such as an index like the S&P 500 (~7%). Commercial customers are assumed to be closer to actual market returns. See for example Dubé, J. P., Hitsch, G. J., & Jindal, P. (2014). The joint identification of utility and discount functions from stated choice data: An application to durable goods adoption. Quantitative Marketing and Economics, 12(4), 331-377.

of the ITC assumption in the "Low-Cost" scenario because there is an established history of ITC extensions and the future of the policy is unknown. The ITC was established in 2005 and has been extended or expanded multiple times including an eight-year extension in 2016. Although other model inputs that might vary, Guidehouse did not explore additional scenarios directly though the DESC analysis. There are several inputs for which Guidehouse chose to use conservative values across all scenarios, meaning that a less conservative assumption would have led to higher estimates of distributed solar adoption. These include:

- Exclusion of multifamily and mobile home customers from the analysis.
- Exclusion of renter populations from the analysis.
- Exclusion of residential households with low modeled credit score from the analysis.
- Escalation of current DESC electric rates only at the rate of inflation.
- Assumption of a customer loan interest rate (cost of debt) of 5%.
- Assumption of 20-year system financial life.
- Inclusion of north-facing systems in generation profile.
- Exclusion of bonus depreciation[7] for commercial and industrial customer value streams.
- Use of a static module capacity factor[8] based on 2020 values.

[7] Bonus depreciation is a tax mechanism incremental to the Modified Accelerated Cost Recovery system that allows commercial entities to accelerate the depreciation of solar PV assets and offset installation costs. There is some debate as to whether even third-party providers offering solar lease agreements can monetize bonus depreciation benefits.
[8] Capacity factors are used to estimate the energy generated per unit of installed capacity.

- Use of lower values for the customer discount rates, reflecting a compromise between "rational" actor methods and values observed in discrete choice experiments.

Q. HOW DOES THE COST OF SOLAR PV IMPACT THE SOLAR FORECAST?

A. The cost of solar PV impacts customer adoption though the calculation of the Long Run Market Share. This happens in a logit formulation that takes customer bill savings as an input. Customer bill savings in turn depends on the value of solar PV generation to the customer and the cost of the system loan. The loan principal depends on the cost of solar PV.

Q. HOW DOES THE SOLAR FORECAST USE HISTORICAL DATA ON SOLAR ADOPTION?

A. The model is calibrated to historical interconnection data, meaning that the simulation was run forward through four historical years starting in 2016 and ending in 2019. Bass diffusion model parameters were tuned via a non-linear optimization routine to minimize the root mean squared error (RMSE) between the installed capacity observed in the historical interconnection data, and those simulated in the model. Current year (2020) interconnection data were held back from the training of the model parameters and used to assess the out-of-sample fit. The RMSE for the

combined training and test data was 4.01, or 1%. The out-of-sample accuracy on the test set was 91%.

Q. PLEASE BRIEFLY EXPLAIN THE FINDINGS AND CONCLUSIONS OF THE SOLAR FORECAST.

A. Key findings of the analysis, which are described in greater detail in Exhibit No. __ (SR-1), include the following:

- The total installed capacity attributed to distributed solar photovoltaics in DESC territory in the "Mid-Cost" scenario is expected to increase by about 69 MW AC during the period 2020 through 2030 due to declining solar PV costs, continued favorable economics for some customer segments, and growth in customer base. Solar growth is dampened due to the sunset of the ITC.
- Installed distributed solar adoption in terms of installed capacity among Residential Single Family, Small Commercial, Medium Commercial, Large Commercial, and Industrial installations has slowed in recent years (2019, 2020). In 2019 when this trend was first visible, the full 30% ITC was still available for all customers.
- Adoption of solar PV is driven by economic and non-economic factors. The economic factors are in large part dependent on tax incentives, net energy metering, and electric rates. Typical Medium Commercial, Large Commercial, and Industrial customers have significant demand components

in their rate. Demand charges are typically not significantly reduced by rooftop solar PV for the average customer as distributed solar systems do not consistently and substantially reduce the customer's peak demand. This decreases the number of customers in these sectors that are willing to adopt solar PV for economic reasons.

- Typical Residential Single Family, Small Commercial, and Other Commercial customers have energy bills that are more driven by energy charges, which are more easily reduced by solar PV systems. This increases the number of customers in these sectors that are willing to adopt solar PV for economic reasons.
- The "Low-Cost" scenario suggests that an extension of the ITC at 30% in 2021 coupled with lower system costs would result in a significant increase in distributed solar adoption. For the Residential Single Family sector, installed capacity additions are forecasted to be about 2 times as high on average in the "Low-Cost" scenario than the "Mid-Cost" scenario. For commercial and industrial sectors, installed capacity additions are expected to be about 2.5 times as high on average.

Q. DOES THIS CONCLUDE YOUR PRE-FILED DIRECT TESTIMONY?

A. Yes, it does.